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# WEB TRACKING ADJUSTMENT DEVICE AND METHOD THROUGH USE OF A BIASED GIMBAL

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## BACKGROUND

The present invention is in the field of mechanisms for tracking moving webs. More specifically this invention relates to the tracking method of the film on the film handling system, and a means for adjusting the film tracking, in electrophotographic printers and copiers.

In high speed electrostatographic reproduction apparatus, it is a common practice to employ an elongated photoconductive belt or web adapted to record transferable images while the web is moving in a path in operative relation with various process stations. Typically the web is supported by, and driven about, at least one roller. With a roller support, there is a tendency for the moving web to shift laterally, or cross-track, with respect to such a roller. This tendency can be due to manufacturing tolerances, such as the inability to manufacture perfectly cylindrical rollers, or to exactly mount the rollers in a web supporting system. Various apparatus for correcting such lateral shifting of roller-supported webs are known, such as crowned rollers, flanged rollers, servo-actuated steering rollers, or self-actuating steering rollers. Crowned rollers generally are not suitable for use with a web in an electrostatographic reproduction apparatus, because they force the web toward the apex of such rollers, cause distortion of the web, and produce local stresses in the web at the crown which can damage the web. Flanged rollers generally are also not suitable because they produce a concentrated loading at the edges of the web, resulting in edge buckling, seam splitting, or excessive edge wear.

Electrostatographic reproduction apparatus therefore typically utilize servo-actuated or self-actuated steering rollers. While such steering rollers generally correct in a gross manner the cross-track shifting of the web, they tend to produce significant lateral movement of the web at an uneven rate as it is re-aligned. This can adversely effect the resulting image quality.

Another method for web tracking is disclosed in U.S. Pat. No. 4,901,903 by Blanding, which describes a steering roller mounted on a pivoted yoke, wherein the roller has an edge guide, and an edge guide adjustment mechanism. In this method, a light tension spring applies a force to the yoke to rotate the roller about a caster axis to impede aberrant lateral movement, and provide corrective action should it occur. This method, though useful, takes a fair amount of very limited space. It is also difficult to make fine adjustments to the tracking using the apparatus disclosed in Blanding.

A method and apparatus for web tracking, and web tracking adjustment is desired which is simple, cost effective, can more effectively use the limited space, and which can make fine adjustments.

## SUMMARY OF THE INVENTION

A method and apparatus for web tracking adjustment for a web handling system is disclosed, comprising biasing a steering roller in a gimbal direction, and adjusting the bias to achieve the desired tracking.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side view of a web/roller system according to an aspect of the invention.

FIGURE 2 is a top view of a continuous web/roller system according to an aspect of the invention.

FIGURE 3 is an isometric view of a steering roller and biasing apparatus according to an aspect of the invention.

FIGURE 4 is an isometric view of a steering roller and biasing apparatus, with a moving web according to an aspect of the invention.

## DETAILED DESCRIPTION

The method and apparatus of the preferred embodiment will be described in accordance with an electrostatographic recording medium. The invention, however, is not limited to methods and apparatus for tracking such a medium, as tracking, and adjustment of the tracking for any web/roller system is within the spirit of the invention.

Various aspects of the invention are presented in Figures 1-4 which are not drawn to scale and in which like components are numbered alike. Referring now to these Figures, in a closed loop web/roller system **8**, at least one steering roller **10** is provided, that is the roller which is free to move in some fashion so as to "steer" the web laterally (parallel to the steering roller **10** longitudinal axis **9**) to bring it to the desired position. One way in which a roller may move is by "gimballing" the roller, i.e. by mounting the roller for pivotal movement about a gimbal axis **6** which is parallel to the direction of linear movement of the entering web, and which preferrably intersects the longitudinal axis **9** of the roller at the midpoint of the roller. Due to functional constraints, the steering roller **10** may not be able to pivot exactly about an axis which intersects the longitudinal axis **9** of the steering roller **10** at the midpoint of the steering roller **10**, if this is the case then an axis which is parallel to the direction of linear movement of the entering web **2**, and comes close to intersecting the steering roller at the midpoint of its longitudinal axis **9** will suffice for the gimbal axis **6**. Another way in which a roller may move is by mounting the roller for pivotal movement about a caster axis **7**, which is an axis perpendicular to the gimbal axis, which intersects the gimbal axis **6** upstream of the roller. A roller may be both "castered" and "gimbaled", which means that such a roller is able to pivot about both the caster axis **7** and the gimbal axis **6**. In the drawings a four roller closed loop system **8** is shown. Besides the steering roller **10** there is also a registration roller **43** and a drive roller **41** which do not steer, and a tension roller **42** which moves in the caster and gimbal direction, and thus allows for some correction of the direction of the

web **2**. This is just an example of one type of system for which the invention is useful, and does not in any way limit the invention to such a system.

According to an aspect of the invention, a method of web tracking adjustment for guiding a moving web **2** in a predetermined path of travel relative to a stationary frame **4** comprises biasing a steering roller **10** in a gimbal direction, and adjusting the bias to achieve desired tracking. By biasing the steering roller **10** in a gimbal direction it is meant that the steering roller is pivoted about the gimbal axis **6** such that the web **2** on the downstream side of the steering roller **10** is not perpendicular to the longitudinal axis **9** of the steering roller **10**. This can be seen in Figure 2, which is a top view of the web/roller system **8**, layed out flat for viewing purposes.

According to a further embodiment of this invention, the steering roller **10** has a lateral constraint **12**, and the bias allows the web **2** to ride against the lateral constraint **12** without damaging the web **2**. In a preferred embodiment, the steering roller **10** is mounted on a roller shaft **14**, and the lateral constraint **12** comprises an edge guide which is rotatably mounted on the roller shaft **14** and is axially slidable relative thereto.

In a further preferred embodiment, the steering roller **10** is biased by a spring **20** having an end one **22** and an end two **24** mounted between the frame **4** and one end of the steering roller **10** such that the spring end one **22** is mounted to the frame **4**, and the spring end two **24** is mounted to the steering roller **10**, such that the spring **20** applies a rotational force on the steering roller **10** about a gimbal axis **6**. This is just one means of biasing the steering roller in the gimbal direction, any suitable means is within the purview of this invention.

According to an aspect of the invention, a means for adjustment is accomplished by applying a pre-load to the spring **20** to achieve the desired tracking. One method for applying this pre-load is by attaching a mounting nut **26** to the spring end one **22**, and threading a mounting screw **28** through the frame **4**, such that the mounting nut **26** is threaded onto the mounting screw **28** to apply the desired pre-load on said spring. There are many ways to apply pre-loading on a spring, and many means for adjusting the pre-load on a spring other

than the method disclosed, all such suitable methods are within the purview of this invention.

According to a further preferred embodiment of the invention, the web tracking apparatus further comprises a housing **5** and spring flexures **30**. The housing **5** is pivotally mounted to the frame **4** such that the housing **5** pivots about the gimbal axis **6**. The steering roller **10** is mounted on a roller shaft **14**, which roller shaft **14** is in turn mounted to the housing **5** by the spring flexures **30**, such that the spring flexures **30** allow the steering roller **10** to pivot about the caster axis **7**, while the housing **5** allows the steering roller **10** to pivot about the gimbal axis **6**.

This invention is a useful means of controlling and adjusting the tracking on a web/roller system. This invention is also useful however, when used in conjunction with a self-adjusting method of control, such as the feedback control described in U.S. Patent No. 4,961,089, by Jamzadeh, which patent is hereby incorporated by reference.